CLAIMS

1. A method for measuring at least one of forces in a peripheral direction and a radial direction of a running tire mounted onto a rim acted upon a ground contact face, in which when a point on an outer peripheral face of the rim is Q and an intersect between a straight line passing through the point Q under no action of external force and extending in the radial direction and an inner peripheral face of a tread portion of the tire is P, said forces are determined from a variant pattern that a relative displacement of the point P to the point Q in the peripheral direction or the radial direction is changed in accordance with a rotating position of the point Q when the point P passes through the ground contact portion of the tire.

2. A method for measuring forces acted upon the tire according to claim 1, wherein a magnetic field formed by a magnet arranged on one of the point P and the point Q is continuously measured by a magnetic sensor arranged on the other of the point P and the point Q, and the variant pattern of the relative displacement between the point P and the point Q is determined by reverse calculation from a variant pattern of a magnetic flux density changed in accordance with the relative displacement.

3. A method for measuring forces acted upon the tire according to claim 2, wherein the measurement of the magnetic flux density is conducted by using the magnet arranged so that a magnetic force line distribution of the magnetic field forms a plane symmetry with respect to a meridional plane of the tire including the point P or the point Q under no action of external force to the tire,

and the force acting in the peripheral direction of the tire is determined from an average between maximum value and minimum value of a variant pattern of a tire peripheral component in the measured magnetic flux density and the force acting in the radial direction of the tire is determined from a difference between the maximum value and the minimum value of the variant pattern.

4. A method for measuring forces acted upon the tire according

to claim 2, wherein the measurement of the magnetic flux density is conducted by using the magnet arranged so that a magnetic force line distribution of the magnetic field forms a plane symmetry with respect to a meridional plane of the tire including the point P or the point Q under no action of external force to the tire,

and the force acting in the radial direction of the tire is determined from a maximum value or a minimum value of a variant pattern of a tire radial component of the measured magnetic flux density.

5. A method for measuring forces acted upon the tire according to claim 2, wherein the measurement of the magnetic flux density is conducted by using the magnet arranged so that a widthwise component of a magnetic flux density of the magnetic field changes along the peripheral direction of the tire under no action of external force to the tire,

and the force acting in the peripheral direction of the tire is determined from an average between maximum value and minimum value of a variant pattern of a tire widthwise component in the measured magnetic flux density and the force acting in the radial direction of the tire is determined from a difference between the maximum value and the minimum value of the variant pattern.

6. A method for measuring forces acted upon the tire according to claim 2, wherein the measurement of the magnetic flux density is carried out in parallel with respect to a pair of magnets arranged near to each other so that changes of widthwise components of magnetic flux densities formed along the peripheral direction of the tire form a reversal relation under no action of external force to the tire,

and when an average value of maximum values in a reversal pattern reversed from a variant pattern of the magnetic flux density of the tire widthwise component measured on one of the magnets and in a variant pattern of the magnetic flux density of the tire widthwise component measured on the other magnet is an average maximum value and an average value of minimum values in these patterns is an

average minimum value, the force acting in the peripheral direction of the tire is determined from an average between the average maximum value and the average minimum value, and the force acting in the radial direction of the tire is determined from a difference between the average maximum value and the average minimum value.

7. An for measuring forces acted upon a tire used in the measuring method claimed in any one of claims 2 to 6, which comprises a magnet arranged on an inner peripheral face of a tread portion, and a magnetic sensor attached directly or indirectly through a fitting jig to an outer peripheral face of a rim.

8. An apparatus for measuring forces acted upon a tire used in the measuring method claimed in any one of claims 2 to 6, which comprises a magnet attached directly or indirectly through a fitting jig to an outer peripheral face of a rim and a magnetic sensor arranged on an inner peripheral face of a tread portion.

9. An apparatus for measuring forces acted upon a tire according to claim 7 or 8, wherein the magnet is constituted with a sheet-shaped magnet having magnetic poles of the same polarity at both ends in a longitudinal direction and a magnetic pole of a polarity opposite to the magnetic poles of both the ends at a center in the longitudinal direction, and the magnet is arranged so as to extend the longitudinal direction in a peripheral direction of the tire.

10. An apparatus for measuring forces acted upon a tire according to claim 7 or 8, wherein the magnet is constituted with two magnets each having magnetic poles of opposite polarities at both ends, and these two magnets are extended in opposite directions to each other in a widthwise direction of the tire and arranged side by side in a peripheral direction of the tire.

11. An apparatus for measuring forces acted upon a tire according to claim 7, wherein the magnet is constituted with at least one sheet-shaped magnet in which distributions of magnetization at front and back faces thereof form a reversal relation to each other.

12. An apparatus for measuring forces acted upon a tire

according to claim 11, wherein the sheet-shaped magnet is constituted with a rectangular rubber sheet of an even thickness in which the magnetization of the same polarity at each of the front and back faces is distributed substantially uniformly over a full face thereof.

13. An apparatus for measuring forces acted upon a tire according to claim 1, wherein the one rectangular sheet-shaped magnet is arranged so as to position a magnet center to the point P and direct a side of the magnet to a peripheral direction.

14. An apparatus for measuring forces acted upon a tire according to claim 12, wherein four rectangular sheet-shaped magnets having the same size are arranged so as to position their magnet centers to apexes of a tetragon having a center at the point P and one side parallel to a peripheral direction of the tire, and a side of each of these magnets is directed to the peripheral direction of the tire, and distances separated between these magnets in the peripheral direction of the tire and the widthwise direction of the tire are not more than 100 mm, respectively, and directions of magnetic poles of the sheet-shaped magnets located at mutually adjacent apexes of the tetragon having a center at the point P are opposed to each other.

15. An apparatus for measuring forces acted upon a tire according to claim 12, wherein two rectangular sheet-shaped magnets having the same size are arranged so as to position their magnet centers to a pair of apexes forming a diagonal relationship of a tetragon having a center at the point P and a side parallel to a peripheral direction of the tire, and a side of each of these magnets is directed to the peripheral direction of the tire, and distances separated between these magnets in the peripheral direction of the tire and the widthwise direction of the tire are not more than 100 mm, respectively, and directions of magnetic poles of these sheet-shaped magnets are made the same.

16. An apparatus for measuring forces acted upon a tire according to claim 12, wherein six rectangular sheet-shaped magnets having the same size are arranged at three rows from side to side along

a peripheral direction of the tire in the same direction and at equal intervals every two magnets, and a side of each of these magnets is directed in the peripheral direction of the tire, and distances separated between these magnets in the peripheral direction of the tire and in the widthwise direction of the tire are not more than 100 mm, respectively, and directions of magnetic poles of these six magnets are opposed to each other even between the adjacent magnets in the peripheral direction of the tire and in the widthwise direction of the tire,

and magnetic sensors are arranged on lines passing through centers of two rectangles formed by mutually adjacent four sheet-shaped magnets under no action of external force to the tire and extending inward and outward in a radial direction in correspondence to each of these rectangles.

17. An apparatus for measuring forces acted upon a tire according to any one of claims 7 to 16, wherein the magnet or the magnetic sensor is indirectly attached to an outer peripheral face of a rim through a fitting jig and at a position separated outward from the outer peripheral face of the rim in a radial direction of the tire.

18. An apparatus for measuring forces acted upon a tire according to claim 17, wherein the fitting jig is a stay or an annular body going round the periphery of the rim.

19. An apparatus for measuring forces acted upon a tire according to claim 17 or 18, which further comprises an adjusting means for adjusting a distance of the magnet or the magnetic sensor separated from the outer peripheral face of the rim, and an operating means for actuating the adjusting means arranged inward in the radial direction of the tire.